Inpatient Hyperglycemia - Adult

Disclaimer: This algorithm has been developed for MD Anderson using a multidisciplinary approach considering circumstances particular to MD Anderson’s specific patient population, services and structure, and clinical information. This is not intended to replace the independent medical or professional judgment of physicians or other health care providers in the context of individual clinical circumstances to determine a patient's care. This algorithm should not be used to treat pregnant women.

Note: Insulin dose adjustments should be made based on the individual patient’s glucose levels. Refer to the Hypoglycemia Management algorithm, as indicated.

**PRESENTATION**

Patient with known diabetes or blood glucose > 180 mg/dL

- Check hemoglobin A1c if not completed within the last 3 months
- Begin POC glucose monitoring

**INITIAL EVALUATION**

Does patient meet diagnostic criteria for hyperglycemic emergency?

- **Yes**
  - See Hyperglycemic Emergency Management (DKA/HHS/EDKA) – Adult algorithm

- **No**
  - Type 1 diabetes or insulin pump or history of total pancreatectomy or history of DKA
  - Page Endocrinology-Diabetes for urgent consultation which requires clinician to clinician communication

  - Type 2 diabetes or steroid induced diabetes/ hyperglycemia
  - See Page 2

  - No history of diabetes
  - See Page 4

DKA = diabetic ketoacidosis
EDKA = euglycemic diabetic ketoacidosis
HHS = hyperosmolar hyperglycemic state
POC = point of care

1 Hemoglobin A1c may be inaccurate if recent blood transfusion within the past three months or severe anemia
2 Diagnostic criteria:
  - DKA: blood glucose > 250 mg/dL and arterial pH < 7.3 or bicarbonate < 15 mEq/L, and moderate ketonuria or ketonemia
  - HHS: blood glucose > 600 mg/dL and arterial pH > 7.3 or bicarbonate > 15 mEq/L, and minimal ketonuria and ketonemia
  - EDKA: blood glucose ≤ 250 mg/dL, arterial pH < 7.3, serum bicarbonate < 15 mEq/L, and moderate ketonuria or ketonemia

[Note: Blood glucose may be lower than expected in patients on SGLT-2 inhibitors (e.g., canagliflozin, dapagliflozin, empagliflozin, ertugliflozin)]
Inpatient Hyperglycemia - Adult

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Note: Insulin dose adjustments should be made based on the individual patient's glucoses. Refer to the Hypoglycemia Management algorithm, as indicated.

**PRESENTATION**
Type 2 diabetes or steroid induced diabetes/hyperglycemia

- Stop high-risk home medications
- Hold metformin if eGFR < 45 mL/minute/1.73 m²

**ASSESSMENT**

Is patient on > 100 units of insulin daily or on Humulin U-500 insulin at home?

- Yes: Consult Endocrinology-Diabetes
- No: See Page 3

Does patient have risk factors for hyperglycemia or hypoglycemia?

- Yes: Initiate basal bolus insulin therapy at 0.4 units/kg/day, subcutaneous with 50% of TDD used for prandial fixed bolus (lispro) dosing and 50% used for basal (glargine) dosing (see Appendix A and B)
  - Assess insulin needs every 24 hours
  - Consider a no concentrated carbohydrate diet
- No: Consult General Internal Medicine (Consultative Medicine - Inpatient Consults) or Endocrinology-Diabetes

Are any glucose levels > 180 mg/dL after 48 hours?

- Yes: Consider resuming home medications, as appropriate
- No: Consider the following as clinically indicated:
  - For patients with hemoglobin A1c < 7.5%:
    - Follow up with treating physician, primary care physician, or endocrinologist
  - For patients with hemoglobin A1c 7.5-9%:
    - Consult Certified Diabetes Care and Education Specialist (Diabetes Educator)
    - Follow up with treating physician, primary care physician, or endocrinologist or arrange ambulatory referral to Consultative Medicine (General Internal Medicine)
  - For patients with hemoglobin A1c > 9% or new to insulin on discharge:
    - Consult Certified Diabetes Care and Education Specialist (Diabetes Educator)
    - Arrange ambulatory referral to Endocrinology-Diabetes

**TREATMENT**

Consult General Internal Medicine (Consultative Medicine - Inpatient Consults) or Endocrinology-Diabetes

---

Note: Refer to Insulin Decision Support Tool to assist in placing orders (for internal use only).

1. Hold home insulin and oral hypoglycemic agents such as sulfonylureas (e.g., glipizide, glyburide, glimepiride, gliclazide), meglitinides (e.g., repaglinide, nateglinide) and SGLT-2 inhibitors (e.g., canagliflozin, dapagliflozin, empagliflozin, ertugliflozin). Generally, metformin and DPP-4 inhibitors (e.g., sitagliptin, linagliptin, saxagliptin) are safe to continue if renal and liver function are stable.

2. Calculation of total daily insulin taken at home: add the total units of all long acting (glargine, degludec, or detemir), intermediate acting (NPH), and short acting (lispro, aspart, glulisine, or regular) insulin in a typical 24 hour period

3. Risk factors for hyperglycemia include: New enteral feedings or PN, Post-operative status, High dose steroids (see Page 3)

4. For critically ill patients, refer to IP Critical Care Glycemic Management order set; consider insulin infusion for 2 consecutive glucose levels > 200 mg/dL within 24 hours.

Refer to Appendix C for transition from insulin infusion to basal bolus insulin therapy.

eGFR = estimated glomerular filtration rate
NPH = neutral protamine Hagedorn
NPO = nothing by mouth
TDD = total daily dose
PN = parenteral nutrition

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Inpatient Hyperglycemia - Adult

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Type 2 Diabetes or Steroid Induced Diabetes/Hyperglycemia

### Risk Factor
- New enteral feedings or PN with glucose level > 180 mg/dL
- Post-operative status
- High risk for hypoglycemia: acute or chronic renal failure or failure to thrive
- High risk for hypoglycemia: poor nutritional status or oral intake, or NPO status for anticipated procedures
- High dose steroids

### Treatment
- Consider tube feeding formulas with lower carbohydrate count/higher fat content if appropriate for patient’s nutritional requirements
- Consider addition of regular insulin to PN based on dextrose content
- Consider Endocrinology-Diabetes consult
- Initiate Post-Operative Insulin Basal Bolus order set (see Appendix B)
  - Assess insulin needs every 24 hours
  - If steroid use is anticipated on discharge, consider Endocrinology-Diabetes consult
- Initiate basal insulin (glargine) at 0.15 units/kg/day subcutaneous and supplemental sliding scale bolus insulin (lispro) subcutaneous (see Appendix A and B)
  - Assess insulin needs every 24 hours
- Initiate basal insulin (glargine) at 0.2 units/kg/day subcutaneous and supplemental sliding scale bolus insulin (lispro) subcutaneous (see Appendix A and B)
  - Assess insulin needs every 24 hours
- Initiate basal bolus insulin therapy at 0.6 units/kg/day subcutaneous with 60% of TDD used for prandial fixed bolus (lispro) dosing and 40% used for basal (glargine) dosing (see Appendix A and B)
  - Assess insulin needs and steroid dosing every 24 hours
  - If steroid use is anticipated on discharge, consider Endocrinology-Diabetes consult
  - Consider a no concentrated carbohydrate diet

### Evaluation
- Are any glucose levels > 180 mg/dL after 48 hours?
  - Yes
  - Consult Endocrinology-Diabetes
  - Discharge planning:
    - Consider resuming home medications, as appropriate
    - Consider the following as clinically indicated:
      - For patients with hemoglobin A1c < 7.5%:
        - Follow up with treating physician, primary care physician, or endocrinologist
      - For patients with hemoglobin A1c 7.5-9%:
        - Consult Certified Diabetes Care and Education Specialist (Diabetes Educator)
        - Follow up with treating physician, primary care physician, or endocrinologist or arrange ambulatory referral to Consultative Medicine (General Internal Medicine)
      - For patients with hemoglobin A1c > 9% or new to insulin on discharge:
        - Consult Certified Diabetes Care and Education Specialist (Diabetes Educator)
        - Arrange ambulatory referral to Endocrinology-Diabetes
  - If steroid use is anticipated on discharge, consider Endocrinology-Diabetes consult
- No

### Follow-Up
- Discharge planning:
  - Consider resuming home medications, as appropriate
  - Consider the following as clinically indicated:
    - For patients with hemoglobin A1c < 7.5%:
      - Follow up with treating physician, primary care physician, or endocrinologist
    - For patients with hemoglobin A1c 7.5-9%:
      - Consult Certified Diabetes Care and Education Specialist (Diabetes Educator)
      - Follow up with treating physician, primary care physician, or endocrinologist or arrange ambulatory referral to Consultative Medicine (General Internal Medicine)
    - For patients with hemoglobin A1c > 9% or new to insulin on discharge:
      - Consult Certified Diabetes Care and Education Specialist (Diabetes Educator)
      - Arrange ambulatory referral to Endocrinology-Diabetes

Note: Refer to Insulin Decision Support Tool to assist in placing orders (for internal use only)

1 For critically ill patients, refer to IP Critical Care Glycemic Management order set; consider insulin infusion for 2 consecutive glucose levels > 200 mg/dL within 24 hours. Refer to Appendix C for transition from insulin infusion to basal bolus insulin therapy.

2 High dose steroid therapy is considered to be ≥ 8 mg/day of dexamethasone, 50 mg/day of prednisone, 40 mg/day of methylprednisolone or 200 mg/day of hydrocortisone

3 In recurrent admissions for chemotherapy containing steroids, please review last Endocrinology-Diabetes note for more specific insulin dose recommendations and use as indicated
Inpatient Hyperglycemia - Adult

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Note: Insulin dose adjustments should be made based on the individual patient's glucose levels. Refer to the Hypoglycemia Management algorithm, as indicated.

**PRESENTATION**

- No history of diabetes
  - Is patient on high dose steroid therapy? Yes
    - Initiate basal bolus insulin therapy at 0.5 units/kg/day subcutaneous with 60% of TDD used for prandial fixed bolus (lispro) dosing and 40% used for basal (glargine) dosing (see Appendix A and B)
    - Assess insulin needs and steroid dosing every 24 hours
    - Consider a no concentrated carbohydrate diet
  - No

- Is patient on high dose steroid therapy? No
  - Assess insulin needs and steroid dosing every 24 hours

**ASSESSMENT**

- Are any glucose levels > 180 mg/dL after 48 hours? Yes
  - Consult Certified Diabetes Care and Education Specialist (Diabetes Educator)
  - Consult Endocrinology-Diabetes
  - Consider initiation of basal bolus insulin therapy at 0.3 units/kg/day subcutaneous with 50% of TDD used for prandial fixed bolus (lispro) dosing and 50% used for basal (glargine) dosing (see Appendix A and B)
  - Assess insulin needs every 24 hours
- No

- Are there 2 consecutive glucose levels > 180 mg/dL within 24 hours? Yes
  - Consult Certified Diabetes Care and Education Specialist (Diabetes Educator)
  - Consult Endocrinology-Diabetes
  - Assess insulin needs and steroid dosing every 24 hours
- No

**TREATMENT**

- Is patient going home on steroid therapy? Yes
  - Consult Certified Diabetes Care and Education Specialist (Diabetes Educator)
  - Consult Endocrinology-Diabetes
  - Assume insulin needs every 24 hours
- No

**Note:** Insulin dose adjustments should be made based on the individual patient’s glucose levels. Refer to the Hypoglycemia Management algorithm, as indicated.

1 High dose steroid therapy is considered to be ≥ 8 mg of dexamethasone, 50 mg of prednisone, 40 mg of methylprednisolone or 200 mg of hydrocortisone per day
2 For critically ill patients, consider insulin infusion for 2 consecutive glucose levels > 200 mg/dL within 24 hours. Refer to Appendix C for transition from insulin infusion to basal bolus insulin therapy.
3 Checkpoint inhibitors: nivolumab, pembrolizumab, durvalumab, atezolizumab, and related drugs. Patients with recent exposure to checkpoint inhibitors are at risk for DKA and should be evaluated for new onset type 1 diabetes mellitus.

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### APPENDIX A: Common Insulin Types and Frequency

<table>
<thead>
<tr>
<th>Insulin Type</th>
<th>Dose Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fast Acting Insulin</strong></td>
<td></td>
</tr>
<tr>
<td>Lispro (Humalog® or Lyumjev®)</td>
<td>Before meals or every 4 hours</td>
</tr>
<tr>
<td>Aspart (Novolog® or Fiasp®)</td>
<td>Before meals or every 4 hours</td>
</tr>
<tr>
<td>Glulisine (Apidra®)</td>
<td>Before meals or every 4 hours</td>
</tr>
<tr>
<td>Regular insulin (Novolin®-R/Humulin®-R)</td>
<td>Before meals or every 6 hours</td>
</tr>
<tr>
<td><strong>Long Acting Insulin</strong></td>
<td></td>
</tr>
<tr>
<td>Glargine (Lantus®/Basaglar®/Toujeo®/Semglee®,1)</td>
<td>Daily or every 12 hours</td>
</tr>
<tr>
<td>Detemir (Levemir®)</td>
<td>Daily or every 12 hours</td>
</tr>
<tr>
<td>Degludec (Tresiba®)1</td>
<td>Daily</td>
</tr>
<tr>
<td><strong>Intermediate Acting Insulin</strong></td>
<td></td>
</tr>
<tr>
<td>NPH (Novolin®-N/Humulin®-N)</td>
<td>Every 12 hours</td>
</tr>
<tr>
<td><strong>Mixed Insulin</strong></td>
<td></td>
</tr>
<tr>
<td>70/30, 75/251, 50/501 (mixes of NPH and a fast acting insulin)</td>
<td>Every 12 hours or every 6 hours with continuous tube feedings</td>
</tr>
</tbody>
</table>

1 Not currently on MD Anderson Formulary

### APPENDIX B: Basal Bolus Insulin Terms

- **Bolus** insulin refers to a dose of fast acting insulin. This is typically comprised of prandial insulin which is scheduled to compensate for the carbohydrate content of a meal and supplemental (or sliding scale) insulin to correct hyperglycemia. Bolus insulin is most effective when given before meals, but supplemental insulin alone can be scheduled for patients who are not eating or are high risk for hypoglycemia.

- **Basal** insulin refers to a dose of long acting insulin given 1 or 2 times daily. These insulins absorb slowly to help maintain stable glucose levels.

- **Supplemental** insulin is dosed based on either weight or total daily insulin requirement.

- A basal/bolus insulin regimen uses both types of insulin to recreate a physiologic pattern of insulin release. This regimen is more effective for most patients than sliding scale supplemental insulin only. Most patients need about half of their insulin as basal and half as bolus. Patients on high doses of steroids will often need more bolus insulin.

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APPENDIX C: ICU Insulin Infusion Transition

**Note:** This does NOT apply to patients with DKA, EDKA, or HHS

Clinical judgement may supersede exact calculation of total daily dose if patient’s clinical status has rapidly changed during transition period.

- Patient on ICU insulin infusion and meets **ALL** of the following criteria:
  - Not in DKA/EDKA/HHS
  - Maintained on insulin infusion ≥ 6 hours
  - Controlled blood glucose (≥ 3 blood glucose < 180 mg/dL in past 6 hours)
  - Steady insulin infusion doses for a minimum of 6 hours (not varying by > 2 units/hour)

  ![Decision Tree](Diagram)

  - **Calculate TDD of insulin infusion by multiplying the average hourly infusion dose from the previous 6 hours by 24 and then multiply by 0.8²,³**

- **Does patient meet any exclusion criteria?**
  - **Yes**
  - **No**

- **NPO or eating < 50% of meals**
- **Eating ≥ 50% of meals or on intermittent enteral feedings**

- **Continuous enteral feedings**
- **Initiate basal insulin (glargine) subcutaneously with dose equal to 50% TDD**
- **POC glucose checks every 6 hours**
- **Discontinue insulin infusion 2 hours after basal insulin administered**
- **Initiate supplemental sliding scale bolus insulin (regular) subcutaneous every 6 hours**
  - TDD < 40 units: Low dose
  - TDD 40 - 80 units: Medium dose
  - TDD > 80 units: High dose
- **See Appendix D for basal/bolus insulin calculation tables**
- **Reassess when patient is tolerating oral diet or enteral feedings as indicated**

- **Discontinue**
- **Eating ≥ 50% of meals or on intermittent enteral feedings**
- **Continuous enteral feedings**
- **Initiate basal insulin (glargine) subcutaneously with dose based on 50% of TDD**
- **POC glucose checks three times daily before meals and at bedtime**
- **Discontinue insulin infusion 2 hours after basal insulin administered**
- **Initiate prandial sliding scale bolus insulin (lispro) subcutaneous using 50% of TDD divided into three pre meal doses**
  - TDD < 40 units: Low dose
  - TDD 40 - 80 units: Medium dose
  - TDD > 80 units: High dose
- **See Appendix D for basal/bolus insulin calculation tables**

- **Does patient meet any exclusion criteria?**
  - **Yes**
  - **No**

- **Calculate TDD of insulin infusion by multiplying the average hourly infusion dose from the previous 6 hours by 24 and then multiply by 0.8²,³**

1. Exclusion criteria includes: Currently receiving vasopressor therapy or insulin infusion dose > 5 units/hour or steroid dose fluctuating more than 20% of enteral feedings not at goal rate
2. Example: Average hourly infusion dose from the previous 6 hours = 3 units/hour; multiple by 24 = 72 units; multiply by 0.8 = 57.6 units, rounded up to 58 units = TDD; see Appendix D for basal/bolus insulin calculation tables
3. Consider decreasing the TDD by 20% for patients with renal dysfunction; Example: TDD = 58 units decreased by 20% = 46 units

**Note:** After transitioning off of insulin infusion, continue to evaluate glycemic control and adjust management as clinically indicated
# APPENDIX D: Basal/Bolus Insulin Dosing Calculation Tables

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## Inpatient Hyperglycemia - Adult

### Note:
- Clinical judgement may supersede exact calculation of total daily dose if patient’s clinical status has rapidly changed during transition period
- Consider dose reduction in patients with renal dysfunction

### NPO or Eating < 50% of Meals

<table>
<thead>
<tr>
<th>Average Hourly Dose of Insulin Infusion</th>
<th>Dose of Basal Insulin (Glargine)</th>
<th>Dose of Prandial (Pre-Meal) Scheduled Short/Rapid Acting</th>
<th>Regular Insulin Supplemental Sliding Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than or equal to 1 unit/hour</td>
<td>9 units once daily</td>
<td>-</td>
<td>Low dose sliding scale every 6 hours</td>
</tr>
<tr>
<td>2 units/hour</td>
<td>19 units once daily</td>
<td>-</td>
<td>Low dose sliding scale every 6 hours</td>
</tr>
<tr>
<td>3 units/hour</td>
<td>28 units once daily</td>
<td>-</td>
<td>Medium dose sliding scale every 6 hours</td>
</tr>
<tr>
<td>4 units/hour</td>
<td>38 units once daily</td>
<td>-</td>
<td>Medium dose sliding scale every 6 hours</td>
</tr>
<tr>
<td>5 units/hour</td>
<td>48 units once daily</td>
<td>-</td>
<td>High dose sliding scale every 6 hours</td>
</tr>
</tbody>
</table>

### Eating ≥ 50% of Meals or on Intermittent Enteral Feedings

<table>
<thead>
<tr>
<th>Average Hourly Dose of Insulin Infusion</th>
<th>Dose of Basal Insulin (Glargine)</th>
<th>Dose of Scheduled Prandial (Pre-Meal) Lispro</th>
<th>Lispro Insulin Supplemental Sliding Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than or equal to 1 unit/hour</td>
<td>9 units once daily</td>
<td>3 units three times daily before meals</td>
<td>Low dose sliding scale three times daily before meals</td>
</tr>
<tr>
<td>2 units/hour</td>
<td>19 units once daily</td>
<td>6 units three times daily before meals</td>
<td>Low dose sliding scale three times daily before meals</td>
</tr>
<tr>
<td>3 units/hour</td>
<td>28 units once daily</td>
<td>9 units three times daily before meals</td>
<td>Medium dose sliding scale three times daily before meals</td>
</tr>
<tr>
<td>4 units/hour</td>
<td>38 units once daily</td>
<td>12 units three times daily before meals</td>
<td>Medium dose sliding scale three times daily before meals</td>
</tr>
<tr>
<td>5 units/hour</td>
<td>48 units once daily</td>
<td>16 units three times daily before meals</td>
<td>High dose sliding scale three times daily before meals</td>
</tr>
</tbody>
</table>

1. Initiate glargine insulin as recommended. For subsequent dosing, hold for glucose < 120 mg/dL.
2. Hold for glucose < 100 mg/dL or if NPO

Continued on next page
### APPENDIX D: Basal/Bolus Insulin Dosing Calculation Tables - continued

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#### Inpatient Hyperglycemia - Adult

**Continuous Enteral Feedings**

<table>
<thead>
<tr>
<th>Average Hourly Dose of Insulin Infusion</th>
<th>Dose of Basal Insulin (Glargine)</th>
<th>Dose of Scheduled Regular Insulin</th>
<th>Regular Insulin Supplemental Sliding Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than or equal to 1 unit/hour</td>
<td>9 units once daily</td>
<td>3 units every 6 hours</td>
<td>Low dose sliding scale every 6 hours</td>
</tr>
<tr>
<td>2 units/hour</td>
<td>19 units once daily</td>
<td>4 units every 6 hours</td>
<td>Low dose sliding scale every 6 hours</td>
</tr>
<tr>
<td>3 units/hour</td>
<td>28 units once daily</td>
<td>7 units every 6 hours</td>
<td>Medium dose sliding scale every 6 hours</td>
</tr>
<tr>
<td>4 units/hour</td>
<td>38 units once daily</td>
<td>9 units every 6 hours</td>
<td>Medium dose sliding scale every 6 hours</td>
</tr>
<tr>
<td>5 units/hour</td>
<td>48 units once daily</td>
<td>12 units every 6 hours</td>
<td>High dose sliding scale every 6 hours</td>
</tr>
</tbody>
</table>

1. Initiate glargine insulin as recommended. For subsequent dosing, hold for glucose < 120 mg/dL.
2. Hold for glucose < 100 mg/dL or if enteral feedings interrupted and notify ICU Team.

**Note:**
- Clinical judgement may supersede exact calculation of total daily dose if patient’s clinical status has rapidly changed during transition period
- Consider dose reduction in patients with renal dysfunction
**SUGGESTED READINGS**


Inpatient Hyperglycemia - Adult

This practice consensus statement is based on majority opinion of the Hyperglycemic Management experts at the University of Texas MD Anderson Cancer Center for the patient population. These experts included:

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